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rather soft, not chitinous as in most Carabid larvæ. There is no sculpturing on the head, and but a single claw on the legs.

At the same time and in the same sand-banks occurred the pupa (Figure 2, enlarged) of the same species. It rested in little pits or cells three quarters of an inch long under flat stones, and was eyeless and white, with the harder parts of the mouth honey-yellow in color.

Though the pupa of the *Adelops* was not found, two larvæ occurred, one in the Labyrinth of Mammoth Cave. Figure 5 represents this interesting form, and 4 *a* one of the antennæ magnified. It bears some resemblance to the larva of *Agathidium* (I know of no figure of a young Catops with which to compare it), but the head is very much larger and nearly as wide as the prothoracic segments. The body tapers rapidly from the prothorax to the end, and is provided with long hairs; it is dull white. There are no traces of eyes.

UNIVERSITY INSTRUCTION IN BOTANY.

BY PROFESSOR W. G. FARLOW.

WITHIN the last few years the interest of the public in botanical questions has very much increased, and not only is there a greater demand for popular lectures, but the introduction of the study of botany into the common schools is beginning to be seriously agitated. But who is to teach the subject? If the public desire to have botany taught in the schools, it is not, as some botanists seem to suppose, because they regard botanical facts as more important than other facts, — historical, philological, etc., — but because, of all the natural sciences, botany is the most easily and cheaply adapted to the school-room, and it is to natural history in some form or other that the public look for a remedy for the evil of book-cramming and memorizing which prevails in our schools. But although botany may serve to counteract the evil, it will not accomplish that object unless in the hands of good teachers, and the very first requisite of a good teacher is a familiarity with the subject he is to teach. If the introduction of botany into the schools is precipitated, the instructors will necessarily be those who are already overburdened with other branches which they are obliged to teach, and which furthermore they teach in exactly the way in which botany or any other natural science should never be taught. The school-teachers themselves must be taught, and that will not be an easy task, considering how little time they have for study, and how many of them have reached an age when entering upon new habits of thought is not easy. Evidently, if there is to be any instruction in botany in the schools which shall amount to anything, it must come from those who have studied the subject at college, for it is in the universities that botanical experts are found as instructors, and it is only there that any systematic and continued study of the subject can be attempted. Let us see what sort of botany is taught in the universities, and whether any improvement is needed or to be desired.

In many of our universities, and we are not now speaking of agricultural colleges, which must be classed with technical schools rather than with universities, the study of botany is elective, and it would not be far from correct to say that it is chosen by a moderately large per cent. of students for a single year, and continued by a much smaller number, perhaps a third or a quarter, during a second year. In all our colleges, whether botany is compulsory or elective, the students are not required or supposed to have any previous acquaintance with the subject, and in all, the first step is to recognize the organs of flowering plants and to learn their names. As soon as possible, the student is requested to provide himself with a manual; a number of flowers, from the field or the hot house, as the season serves, is then placed in his hands, and he is required, if we may be allowed the expression, to "go through" them. This last process varies somewhat with the fancy of the instructor and the laboratory facilities of the college. Where the botanical chair is combined with those of zoölogy, chemistry, and the modern languages, the "going through" consists in tracking a flower, just as though it were a thief or a woodchuck, to its hiding-place in the manual by means of a key. A neat pencil mark against the specific name serves to indicate one step onward in the mental development of the student. In those colleges where there is a greater division of labor, and one man is obliged to teach only botany and zoölogy, there is generally provided a printed schedule in which the student as he proceeds records the number of stamens and pistils, the interesting fact whether the ovary is superior or inferior, and other similar details, until, having filled his schedule, he is at liberty to turn to the key and follow the course we have previously described.

In a few colleges, during the first year, students of botany, in addition to the analysis of flowering plants, hear a few lectures on cryptogams or vegetable physiology, but the great fact is never lost sight of that the aim and end of all botanical instruction is, at the end of a year's study, to be able to take one's manual, and, with a certain degree of facility, find the names of common flowering plants. That is the first task to be accomplished, and not until it is accomplished is any student to be allowed to take up anything else. As a matter of fact, comparatively few students pursue the subject for a second year, if by the university regulations they are allowed to give it up; and the question suggests itself, What is the result of a botanical course of one year? The good students who have, under the circumstances, made the best possible use of their time, are able to analyze simple flowering plants with tolerable ease, and know the characters of some of the orders of phænogams; and those who have not studied so faithfully are perhaps able to explain to a cruelly skeptical father that a rose-bush is very much like an apple-tree, or to compare notes with Emily, who has just returned from Miss Smith's Institution for Young Ladies, and, after some months' study, is not quite sure whether the calyx is inside or outside the petals.

We must confess that it seems to us a mistaken notion to teach botany as though the naming of phænogams, or even the general morphology of phænogams, was any more important than other topics. We know from experience that but a very small per cent. of the students who study botany in college ever do learn enough to enable them to analyze flowers with any ease, and that even the few who can, rarely continue the study after leaving college, from want of either time or opportunity for herborizing. The botanical students in any university may be divided into three classes: those who have a passion, a natural aptitude, for the subject, whose number is always very small, and includes those who are to become the experts and higher teachers of botany; those of good ability and industry, who elect botany because they hope to find it an aid afterwards when they shall study a profession or become school-teachers; and those who select the study as part of a plan of general culture and improvement. There is a fourth class, but we never mention that, composed of young gentlemen whose principal aim in coming to college seems to be to get as little good out of it as possible. We should like to know which of these three classes is benefited by the almost exclusive study of phænogams for the first and, in the case of many of them, the only year of their botanical studies. Those who wish for general culture get a smattering of the technicalities of one branch of the vegetable kingdom, and are in absolute ignorance of all the rest. Those who think a one year's course, as at present arranged, will help them as teachers, will find themselves without a general notion of the vegetable kingdom, without which it will not be easy to instruct others. The medical man will find that he would be able to recognize several useful plants were it not for the fact that they do not grow within several hundred miles of his home, and, on the other hand, that he has no knowledge either of vegetable histology, which would be a great assistance in his pathological studies, or of fungi, which are interesting in connection with the origin of several diseases.

If we look at the effect of the usual training on the first class we have mentioned, those who really wish to become botanists, the conclusion we must draw is not flattering. Why is it that so few botanical workers are found in this country? Where are the young men of ability and enthusiasm who ought to be working up some of the interesting botanical questions? They are all — studying zoölogy. As botanists, we cannot of course admit that botany is in itself any less interesting than zoölogy, and if we turn to Germany, for example, we find that the proportion of young men who enter on a botanical career there is as large as that of those devoting themselves to zoölogy. If at the present day we are feeling the want of young botanists to investigate or instruct, we must not forget that at the door of every botanical lecture-room the would-be enthusiast has encountered a manual of flowering plants, through which he must make his way if he would see any light beyond. What wonder that many were attracted to the other house, where manuals were not so much in vogue, and the study of development encouraged. It must be said with shame that not a single work on the development or minute histology of any plant or group of plants has ever been written by an American, if we except some of Sullivant's bryological works. It has finally become the prevailing belief that if one would do anything for botany he must find or make new species. It is certainly of the greatest importance that eventually all species of plants should be described, but it is very injurious to have one who has not a large library and herbarium attempt to decide what is new and what is not.

We would by no means disparage the systematic study of phænogams, but by conveying the idea that such a study underlies and is the key to the whole science of botany, numbers of young men whose talents and services could ill be spared have been driven to other branches of natural history. The great mistake seems to us to have been that it has been attempted to educate all who study botany as though they intended to become botanical specialists in the department of descriptive phænogamy, whereas not one in a thousand has such an intention or desire.

We would see the instruction in botany for the first year rather directed to give a good general view of the whole vegetable kingdom, than to enable the student to follow out specific analysis in any one department. We would not forget that botany is one of the divisions of biology; we would, as far as possible, examine plants in action, and would let the student devote his time for the first year to the examination of a few illustrations of the different types of vegetable life, from the highest to the lowest, without any attempt at teaching particular genera and species. We would teach the student how to investigate for himself, and avoid imparting any encyclopædic knowledge. At the close of one year's study the student would be in a condition to know in which direction he prefers to work, and in his second and later years of study he could pursue more and more in detail the department which his own taste may dictate, not, however, entirely neglecting others. We think it absolutely necessary that in the first year of study a general course should be pursued, in which the student should be obliged to think for himself, and should not be allowed to depend on books.

To enter into particulars, we should prefer something of this kind: We suppose the college term to begin about the first of October and end the first of the following July, and that the student spends three hours a day for three days in the week in the laboratory, or, in case a lecture is given on any day, only two hours of laboratory work. The material is selected to suit the climate of the Northern States.

OCTOBER AND NOVEMBER. — One lecture a week. (A.) Illustrations of *Palmella*, *Nostoc*, *Oscillaria*, *Desmids*, *Spirogyra*, etc., to show the structure of the cell, and acquire facility in the use of the compound microscope and in making preparations.

(B.) *Myxomycetes*, to examine the plasmodium. *Nitella*, to show the movements of protoplasm.

(C.) *Mucor Syzygites*, to illustrate conjugation.

(D.) *Peronospora viticola*, to show oöspores and zoöspores.

DECEMBER, JANUARY, AND FEBRUARY. — (A.) *Basidiomy-*

cetes, illustrated by *Agaricus*, *Lactarius*, *Corticium*, etc., alcoholic material, to show structure of mycelium and hymenium.

(B.) *Ascomycetes*, showing ascospores, conidia, pycnidia, etc., illustrated by *Eurotium*, *Phyllactinia*, *Microsphœria*, *Peziza*, *Morchella*, *Sphœria morbosa*, *Sphœria herbarum*, *Hypomyces*, etc.

(C.) Lichens of different kinds.

(D.) *Fucus*, *Laminaria*, *Ectocarpus*, *Polysiphonia*, *Callithamnion*. (These last can be obtained alive in winter by those living near the sea-coast, and all except Fucus can be kept perfectly well in alcohol.)

The subjects just mentioned for December, January, and February should occupy two days out of the three, part of the time being spent in attending lectures and part in laboratory work. The third day, the organography of flowering plants should be studied.

MARCH. — (A.) Ferns and mosses, structure of prothallus and fruit, one day in the week.

(B.) Vegetable physiology, one day.

(C.) Organography of flowering plants, one day.

APRIL, MAY, AND JUNE. — One day a week to histology of higher plants. Two days to analysis of flowering plants. With a certain number of lectures on vegetable physiology, and in early summer a glance at the *Uredinei*, illustrated by acidial and uredo forms and dried material of teleutospores.

Such would be the course which we should advise for a person old enough, and with sufficient previous training to be admitted to college. For persons in their first and second childhood, kindergarten methods will do very well, but for young men we prefer work. The course we have laid down requires work with the compound microscope from the very beginning. There is no denying that the microscope has caused a revolution in botany, and no botanist of the present day, no matter what department he may take up, can afford to be ignorant of the practical working of that instrument. Vegetable histology is the very A B C of botany, and no botanical work can be solid unless it rests on that foundation. To be sure, the microscopical societies have done their best to bring the microscope into disrepute, by encouraging the notion that there is a department of microscopy apart from botany, zoölogy, and pathology, and by striving to recommend to the public large and expensive instruments, which, however perfect they may be optically, are ill adapted for steady work and for the slender means of most young people. The microscope as an optical instrument comes under the province of physics, and microscopy is no more a science apart from biology and pathology than is cutlery. We might just as well have a department of cutlery in which we could include those animals and plants which are usually studied by sections made with razors and knives. Every college where botany is taught should be provided with a number of compound microscopes. Microscopes sufficiently good for ordinary purposes can be purchased in Europe for thirty dollars gold, or even somewhat less, and can be imported free of duty for college use. Even with duty paid, fifty dollars ought to secure a very fair French or German microscope.

Our proposed course implies a tolerably large proportion of laboratory work, and we may be allowed here to say a few words on what seems to be a growing evil in this country, the abuse of laboratories. A few years ago, when it was seen that instruction in natural history could not be imparted successfully from books alone, laboratories were introduced to remedy the evil. It was said, In the laboratory the student will see the object itself; he will learn to compare, to reason, and, instead of merely committing a number of pages to memory, he will have a practical knowledge of the subject. But the laboratory system has worked in a curious way, although in a way which might have been anticipated, and it has not proved such a complete panacea as had been expected. If, on the one hand, to those who are anxious to learn and are fond of investigation, laboratory exercises are of incalculable value, it must be said, on the other hand, that the average American student is thoroughly impressed with the idea that, if he does not understand a thing at once, it is the business of the instructor to explain it to him. It never occurs to him that it may be for his advantage to work the thing out himself. From childhood up, having been taught that education consists in the acquisition of facts, he cannot see that the mere process of acquiring a fact may be of more importance than the fact itself. But the case is even worse. The fourth class of students which we described, those who wish to have as easy a time as possible, regard the laboratories as especially created for the purpose of escaping study, and to the laboratories they flock in crowds. They seriously interfere with the work of the good students, by compelling the instructor to spend a great part of his time in explaining things which they ought to work out for themselves. If a shirk is a nuisance in the lecture-room, he is tenfold a nuisance in the laboratory, where he wastes not only time, but room and working materials.

Were the courses in our colleges elective, in the true sense of the word, this difficulty of the crowding of laboratories by students who are not in earnest would not arise. But even where the botanical course is nominally elective, there is a certain compulsion employed in the form of check-lists or compulsory recitations. As it is, we see no other way out of the difficulty than to divide a botanical class of any size into two sections; one including those who are willing to work, who should have laboratory privileges; the other including the shirks, who should be required only to attend lectures and recitations, and who should, of course, be marked on a lower scale. There is no good reason why a college should provide laboratory room and equipments for those whose principal object in going to the laboratory is to try to worm out of the instructor the questions of the next examination paper. There is another class of well-meaning but exasperating students, birds of passage we must call them, who have usually not more than fifteen or twenty minutes to spend at any one time in the laboratory. We see no reason why, if a student actually has no time at his disposal, he should be allowed to throw a laboratory into confusion by a series of abrupt entrances and as abrupt departures.

We have purposely omitted any lectures on economic botany from our proposed course. However useful a study it may be for apothecaries, it is entirely unadapted to college students. They might just as well try to learn so many pages out of the dictionary. It would be very desirable to remember the names and orders of a large number of useful and injurious plants. But no one ever does who is not obliged to lecture twice a year on the subject, and even then he is compelled to refresh his memory by frequent perusal of certain books whose titles we will not mention, for fear that it may be said that we are betraying professional secrets.

In Germany the botanical professors generally give a principal course of lectures, which is attended by those who are paying particular attention to the science, and a shorter accessory course, on some limited subject, which is attended by those who simply wish to know what is going on in the botanical world, without making any detailed study. It seems to us that something similar would be advisable in this country. There is always a number of students who would like to hear a few lectures on some of the most interesting topics relating to botany, students intending to become clergymen, lawyers, business men, whose time is so occupied with historical or philosophical courses that they could not take a regular botanical course. The few minutes which they could spend in a laboratory would be time thrown away. They want a few plain lectures on some limited topic, and the topic should be changed from year to year. On one year there might be, for instance, six lectures on fertilization of higher plants. The next year a course on the lower limit of the vegetable kingdom. Or there might be two or three courses of six lectures during the same year.

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RECENT LITERATURE.

A FEW SUGGESTIONS ON TREE-PLANTING.[1] — The increased interest awakened of late in arboriculture may be attributed in part to a realizing sense that we have been forest-spendthrifts, and that it is about time for us to begin economizing, and if possible repair our wasted patrimony.. There is a vague fear that certain dangers are impending over us as a penalty for recklessly clearing the timber lands, and there seems to be a very general wish that our neighbors should do something at once. Now, what to do and how to do it are not so clear.

In a course of lectures last winter at the Lowell Institute, Dr. Hough gave a frank statement of the difficulties. In the Eastern States the traditions of two hundred years are against tree-planting; there is no concert of action in any community; there are many contingencies which may render the scheme in any one case a very hazardous one, and there is, at all events, a long time to wait for any pecuniary profit.

Besides these difficulties we may state another, namely, that in few towns are the assessors of taxes in a right frame of mind. And so each man would gladly see his neighbor do something at once. This little pamphlet by Mr. Sargent gives many sensible hints as to what to do, and we call attention to the paper because it is a practical one, advocating practicable methods. Meanwhile, as our communities are acting on Professor Northrop's suggestion to plant centennial trees in the towns this year, can they not try a few centennial forests?

DIE PFLANZENWELT NORWEGENS.[2] — This work is in two parts. The first, published in 1873, is a general account of the physical features of Norway and Sweden, with particular reference to the distribution of

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[1] *A Few Suggestions on Tree-Planting.* By C. S. SARGENT, A. B., Director of the Arnold Arboretum of Harvard University. From Report of Massachusetts State Board of Agriculture, 1875.

[2] *Die Pflanzenwelt Norwegens.* Von DR. F. C. SCHÜBELER. (The Vegetation of Norway, by Professor Schübeler, of the University in Christiania.)